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Parts V–VI SECTION B Volume 25

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CONTENTS

# PROCEEDINGS

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PARTS V–VI] SECTION B [VOL. 25

CONTRIBUTIONS TO THE MORPHOLOGY OF THE NERVOUS SYSTEM OF MATURE LARVA OF *PRODENIA LITURA* FAB. (LEP-NOCTUIDÆ)

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(Communicated by Dr. M. D. L. Srivastava)

INTRODUCTION

A LOOK into the existing literature on the nervous system of caterpillars shows that this branch has remained neglected not only in the past but also during the last one century, as is evident from the fact that the subject has attracted hardly half-a-dozen workers during the last hundred years; therefore, the present study was taken up.

HISTORICAL ACCOUNT

Newport (1832–34) was one of the earliest workers in this field. He described changes in the nervous system of the larva of *Sphinx* undergoing metamorphosis, and gave a good account of the system, but could not identify and detect all the nerves. Nearly 80 years after Newport, Peterson (1912) described the nervous system of *Protoparce* in detail. In fact, Peterson's paper has formed the basis of the more recent papers on the subject, but Peterson also could not trace or identify all the nerves. Following him, Du Porte (1912) worked on the system in the larva of *Sphida obliqua* Wlk.

and Swaine (1920) on *Sthenopis thule*. Recently Hillemann (1933) has published a detailed account of the system in *Papilio*. He recognised for the first time the post-median nerves.

MATERIAL AND TECHNIQUE

The mature larvæ of *Prodenia litura* both preserved and fresh were dissected under a dissecting binocular microscope. For dissecting out finer nerves Delafield's Hæmatoxylin diluted to nearly 6 times was poured over the specimen, allowed to stand for about ½ to 1 minute and washed under tap-water. If required such specimen were treated with a drop or two of acid water and washed. By this treatment the nerves became easily distinguishable by their dark bluish colour from trachea and muscles, etc. For the first time, injections were tried on the preserved larvæ. Borax carmine was injected in the larvæ which were left over in 70% alcohol for nearly a week. The excess of stain was slowly washed away by this process. Later they were dissected and it was noted that the muscles took up fine reddish stain, nerves little stained and tracheæ were practically unaffected.

OBSERVATIONS

(A) *Ganglia of the Head*

Supra-œsophageal Ganglion (Figs. 1 & 4) (*Sup.*).—This is the largest ganglion of the nervous system, situated on the dorso-ventrally directed pharynx and distinctly bilobed.

(1) *Crura Cerebri* (*cc*) originate as large cords from the middle of the latero-caudal margin of the supra-œsophageal ganglion and extend ventrocaudally, passing on either side of the pharynx and uniting with the subœsophageal ganglion.

(2) *Optic Nerves* (*o.n.*) are quite small and originate from the anterolateral angles of the supra-œsophageal ganglion and are most cephalad of all nerves arising from this ganglion. They extend in a cephalo-lateral direction to near the ocellar region, where they divide into 6 branches supplying one to each of the ocellus.

(3) *Antennal Nerves* (*at.n.*) are nearly as prominent as the optic nerves and arise very close to them, but a little caudad. They extend cephaloventrad and innervate the antennæ.

(4) *Clypeo-labral Nerves* (*cl.lb.n.*) are most caudad of all the nerves arising from this region of the supra-œsophageal ganglion. Each nerve divides into 2 mesially directed branches, one forming the frontal ganglion connective and the second constituting the clypeo-labral nerve. This nerve branches off into several small branches.

Sub-œsophageal Ganglion (*Sub.*) is much smaller than the supra-œsophageal ganglion and placed ventrally below the pharynx. Several nerves arise from it.

Sub-œsophageal Commissures (*Sub.*) arise from the crura cerebri on their inner surface near about the middle, and encircle the pharynx like a ring. Both Peterson (1912) and Hillemann (1933) consider these " cords to be homologous to the connective nerve of the commissure which have come together to form a nerve ring about the pharynx instead of proceeding independently". In fact Peterson thinks " that the sub-œsophageal commissures are nothing more than a connective nerve that have united to form a semicircle about the pharynx".

Mandibular and Labial Nerve (*md.lb.n.*) originating near the crura cerebri, slightly caudo-mesial of them, divide into 2 branches. The large and thick mandibular branch extending cephalo-ventrad innervates the muscles of the mandible of its side. The second branch is the labial nerve—a fine branch, extending caudo-ventrad and innervating the labium.

Maxillary Nerves (*mx.n.*) arising ventro-laterally caudad to the mandibular labial nerve are much smaller. They soon branch and innervate the maxillæ.

Labial Nerve (*lb.n.*) arises postero-dorsally to the maxillary nerve. Peterson (1912) could not fix up the identity of this nerve and has labelled it as unidentified nerve. Hillemann (1933) who first traced it to the labium called it the labial nerve and considers it as the second set of labial nerves. In the present insect, this nerve was also traced to the labium and hence it lends support to the findings of Hillemann. Labial nerves of Peterson correspond to the labial branch nerve here.

Ventral Nerves (*v*) arising from the mid-ventral region of the ganglion extending dorso-caudally innervate caudal region of the head.

(B) *Ganglia of the Thorax*

Each of the thoracic segments contains one ganglion. These ganglia are definitely larger than those of the abdomen and are somewhat circular in outline. They are similar and situated near the floor of the segment.

Prothoracic Ganglion.—The commissures extending from the prothoracic ganglia, more or less remain separate and are very short.

Lateral Nerves (*l*) arise from the antero-lateral aspect of the ganglion and extend laterad and divide into many small branches and innervate the lateral areas.

Ventral Nerves (*v*) originate from the postero-lateral margin of the ganglia and are produced laterad along with the trachea.

Median Nerve (*m*) arises from the medio-dorsal surface of the ganglion and proceeds caudad and divides into the usual transverse nerves, which proceed laterad and meet with the connectives from the mesothorax near the anterior margin of the mesothoracic segments.

Meso- and Meta-thoracic Ganglia.—These two ganglia are identically similar, but the meso-thoracic ganglion lies in the anterior part of the segment while the meta-thoracic one lies a little posterior to the middle of the segment.

Connectives (*c*).—Extending caudad from the posterior end of the ganglia and forking after some distance are two cords separated from one another throughout their length, excepting for a short distance in the anterior region. They are farthest removed from one another in the anterior two-third of their length, thus forming a diamond-shaped area within which is located the ventral Sympathetic Nervous System. The connectives between the meso- and meta-thoracic ganglia is nearly about twice the length of the connectives between meta-thoracic and the first abdominal ganglia. In fact this connective between the meta-thoracic and the first abdominal is the shortest of all the connectives so far described. One noteworthy feature of the ganglia as described by Hillemann (1933) is the total absence of an additional web-like sympathetic plexus as found in the abdominal ganglia, about which Peterson (1912) remains silent. The observations of the author go to substantiate Hillemann's statement. The median nerve along with the transverse nerves form the ventral sympathetic system.

Connective Nerve (*con.n.*).—The present observations of the author about the place of origin of these connective nerves do not agree with any of the following workers: Hamman (1908), Peterson (1912) and Hillemann (1933). All of them have stated that these arise from the middle of the connectives of the diamond-shaped area, but in *Prodenia litura* Fab. they arise as usual from the lateral angle from the place just before the connectives entering the ganglia, *i.e.*, very near the meta-thoracic ganglion and they proceed in a latero-cephalad (45°) direction from the meta-thoracic ganglion; after a short distance they give out a branch anteriorly on either side which fuse with the transverse nerves thus describing an irregular hexagonal structure.

Median Nerve (*m*) arising from the posterior margin of the ganglion in between the connectives is the median nerve. It proceeds caudad directly, passing between the connectives for nearly one-third of the length of the connective cord and then it bifurcates into two transverse nerves.

Transverse Nerves (*tn*).—The transverse nerves after their origin, proceed first slightly cephalad and then laterad till they meet the anterior branch of the connective nerve. The transverse nerve along with the median nerve form the ventral sympathetic system.

Post-median Nerve (*pmn.*) is a fine nerve which arises from the point of origin of transverse nerve. It runs directly caudad and enters the middle of the antero-dorsal surface of the ganglia.

Ventral Nerves.—In both the thoracic ganglia, the ventral nerves arise from near the middle of the lateral margins of the ganglia. The mesothoracic ones run directly laterad and those of the metathorax run cephalo-laterad. Both the ventral nerves innervate the ventral portion of the thorax.

(C) *Ganglia of the Abdomen* (Fig. 2, *1st.abd.gng.*)

First to sixth abdominal ganglia are located either in the middle or cephalic part of each of the abdominal segment. For the major part the ganglia of first to sixth segments are typical and identically the same. So the description of one ganglion will suffice for others. These ganglia are the smallest in the Central Nervous System. Sympathetic plexi are closely associated with all the ganglia and lateral nerves run from all of them. Each consists of the following parts:—

Connectives (*c*) consist of 2 cords showing a median furrow and separated at about the middle of their length, but not far apart. The connectives leave at the posterior end of the ganglion and proceed posteriorly to unite with the second ganglion at their cephalic or anterior end. The commissure between the metathoracic and first abdominal, and between sixth and seventh abdominal ganglia are the smallest. Rest all are of nearly equal length.

Lateral Nerves (*l*) are two branched which arise from the lateral margins of the cephalic part of the ganglion and proceed at first cephalo-laterad for a short distance and then curve back and run directly laterad. They innervate the latero-dorsal region of the body wall.

Ventral Nerves (*v*) arise directly caudad and slightly ventrad of the lateral nerves from the lateral margins, slightly posterior to the middle of the ganglion. They extend latero-caudad and innervate the ventral parts of the body segment.

Median Nerve (*m*) takes its origin from the posterior part of the ganglion, though it appears to arise from the point of bifurcation of the connectives, and it extends caudad for a short distance, dorsal to and between the two

connective cords at its caudal end, near the ganglion it forms and gives rise to two transverse nerves.

Transverse Nerves (*tn*) arising from the median trunk extend caudo-laterad in the opposite direction after running for a short distance, bend abruptly and proceed antero-laterad and ventrad. They run somewhat parallel to the lateral nerves. The transverse nerve gives rise to a web of nerve fibres which connects the lateral nerve and the ganglion.

Post-Median Nerve (*pmn.*).—This nerve was described for the first time by Hillemann (1933). Snodgrass (1935) in his work figured the nerve but did not mention anything about it. It is a short and very fine nerve, arising from the point of bifurcation of the median nerve and runs caudad entering the antero-dorsal surface of the ganglion after a very short distance.

Sympathetic Plexus (*px.*) (as already mentioned above) occurs between the ganglia, the transverse and lateral nerves in the form of a web, proceed outward for a distance equal to the length of the ganglion. The transverse nerves run antero-dorsally near the end of the plexus.

Tracheation.—Immediately anterior to the origin of the ventral nerve, enter a pair of small thread-like tracheal branches from a ventro-lateral and slightly caudal direction and are inserted into the lateral sides of the ganglion. These tracheæ (of both sides) are derived from the transverse trachea of the respective abdominal segments, located a short distance postero-ventral to the ganglia.

Seventh and Eighth Abdominal Ganglia (Fig. 3)

The ganglia of the seventh and eighth abdominal segments are fused together, forming a double ganglion situated in the seventh abdominal segment. The connectives connecting the ganglia are wanting. This modification brings about certain changes in nerves. The anterior half of the ganglia which represents the seventh ganglion is smaller than the first six abdominal ganglia and nerves are also similarly arranged, hence needs no further comment, but the posterior portion of this ganglion represents the eighth abdominal ganglia. The elimination of the connectives causes change in various ways. The nerves are lengthened, there is also a change in the place of their origin, and direction. A noteworthy feature of this segment is the absence of any post-median nerve and sympathetic plexus. All the nerves from this ganglion are definitely thicker than those of the previous segments.

Lateral Nerves (*l*) are comparatively large nerves and they—originate from the dorso-caudal end of the ganglion and extend somewhat laterad

and then divide into two main branches. These branches run further caudad and ventrad and innervate the latero-ventral portions of the eighth abdominal segments.

Ventral Nerves (*v*) originate from the postero-caudal angles of the ganglia and run backwards almost parallel with the lateral nerves throughout their length and outer to these they extend into the eighth abdominal segment, divide and innervate the caudo-ventral portion of the segment.

Median Nerve (*m*) originates from the dorsal surface of the double ganglion near about the middle portion and proceeds for a short distance posteriorly and bifurcates.

Transverse Nerves (*tn*) arise as usual from the point of bifurcation of the median nerve and instead of running exactly parallel with the lateral nerves as in other preceding segments; they follow a somewhat caudo-laterad direction for a considerable distance where they divide and supply the ventro-lateral region of the eighth abdominal segment. There is total absence of any plexus between transverse and lateral nerves and here the author's observations coincide with those of Peterson and Hillemann.

Tracheation (*t.*).—The tracheal branches which innervate this ganglion arise from a transverse trachea (*tt.*) situated posterior to the ganglion. They are very fine, long branches running almost with the lateral nerves entering the ganglia a little ventral to the lateral nerve.

From the larger size of the terminal ganglia and because of the numerous nerves arising from it, it is clearly evident that it has been formed by the fusion of the last two or more ganglia.

Stomodæal System.—The Stomodæal system of *Prodenia* is more or less like that of a typical noctuid larva described by Snodgrass (1935). It also bears very close resemblance to that of *Protoparce* (Fig. 4).

The sympathetic system exists in close connection with the supra-œsophageal ganglia and this system is clearly divided into an unpaired or the vague system, consisting of frontal connectives of the two sides which unite on the meron to form a small frontal ganglion (*f. g.*). Extending caudad from its caudal end along the dorsal surface of pharynx and œsophagus is the recurrent nerve (*rn*). This nerve supplies the muscles of the region and forks posteriorly. At the point of forking there is a little swelling which has often been termed as Vagus ganglion. It is not well defined in this insect. The forked branches of the recurrent nerve continue as stomatogastric nerve and encircle the œsophagus. The second part is formed of two anterior lateral ganglia or the occipital ganglia of Snodgrass; other nerves are as usual.

DISCUSSION

While there is a more or less general agreement among the workers regarding the morphological nature of the parts of the nervous system, doubt exists in respect of the true nature of the terminal ganglion. On account of its unusually large size and origin of a number of nerves from it, it has been recognized as a fused ganglion, formed by the fusion of two or more abdominal ganglia. But whether it is composed of two ganglia or three is far from certain. Peterson (1912) working on *Protoparce* and Hillemann (1933) on *Papilio* do not express any opinion on this issue in spite of their commendable work. However, Oundman (1884) (quoted by Hamman) stated that in *Machilis maritima*, the last abdominal ganglion originated from the fusion of the last three abdominal ganglia. He substantiated his assertion by describing remnants of three pairs of transverse nerves on the dorsal side of the terminal ganglion and regarded these as indicating the original boundaries of the fused ganglion. Hamman (1908) does not report such remnants of transverse nerve in *Corydalis cornuta*, but he also considers it possible that the terminal ganglia is composed of three ganglia, and thinks that the " nerves corresponding to a third have disappeared". On the other hand Peterson in *Protoparce* and Hillemann in *Papilio* mentioned clearly the presence of two sets of nerves in connection with the terminal ganglion.

If we base our decision regarding the nature of the terminal ganglion on Oundman's own criterion, that is, the number of paired nerves arising from it, we find that in all the cases reported except that worked out by Oundman himself, the number of such paired nerves reported is only two. In the present case also the author has clearly noted only two pairs of nerves from the ganglion and therefore he is inclined to regard it as arising from the union of the last two abdominal ganglia. Regarding Hamman's suggestion that the third pair of nerves might have disappeared, two facts are worth noting: firstly if the presence of two pairs of nerves is due to the suppression of disappearance of the last pair, we should see the third pair also in a few cases other than Oundman's; secondly, in the present case, the second pair of nerves itself arises more or less from the posterior extremity of the ganglion, so that, unless we presume that the middle pair of nerves has disappeared, we have to conclude that the ganglion is composed of two ganglia only. Nevertheless, the inference needs confirmation by early developmental studies which the author has presently not been able to do.

SUMMARY

The nervous system of a noctuid larva has been worked for the first time. The work agrees well with those of Peterson and Hillemann in its major aspects excepting for the following points:—

(1) The unidentified nerve of Peterson has been found to innervate the labium.

(2) The sympathetic plexus is absent in the meso- and meta-thoracic ganglia.

(3) The connective nerves instead of arising from the middle of the Connectives arise just before the Connectives enter ganglia.

(4) Post-median nerves were traced from the point of bifurcation of transverse nerves.

(5) The last abdominal ganglia show double set of nerves originating from them which has led the author to believe that only last two ganglia have fused rather than the last three to produce this compound ganglia.

ACKNOWLEDGEMENTS

The work was carried out under the supervision of Sri. S. C. Verma, Reader, Zoology Department, Allahabad University, to whom the author is extremely grateful for his constant guidance and encouragement during the course of the work, to Dr. U. S. Srivastava for his timely help and helpful suggestions, and to the University authorities for the award of the Empress Victoria Readership.

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EXPLANATION OF PLATE

FIG. 1. Nerves and ganglia of head and thorax.

FIG. 2. Nerves of the first abdominal ganglion.

FIG. 3. Nerves of the last (fused) abdominal ganglia.

FIG. 4. Stomodeal nerves and other nerves of the head.

ABBREVIATIONS

at.n., Antennal nerve; *c*, Connectives; *cc*, Crura Cerebri; *cl.lb.n.*, Clypeo labral nerve; *con.n.*, Connective nerve; *f.g.*, Frontal ganglia; *l*, Lateral nerve; *lb.n.*, Labial nerve; *m*, Median nerve; *md. and lb. n.*, Mandibular and Labial nerve; *mx.n.*, Maxillary nerve; *o.n.*, Optic nerve; *pmn.*, Post-median nerve; *px.*, Sympathetic plexus; *r.n.*, Recurrent nerve; *Sub.*, Sub-œsophageal ganglia; *Sup.*, Supra-œsophageal ganglia; *tn.*, Transverse nerve; *tt.*, Tracheation; *v.*, Ventral nerve.

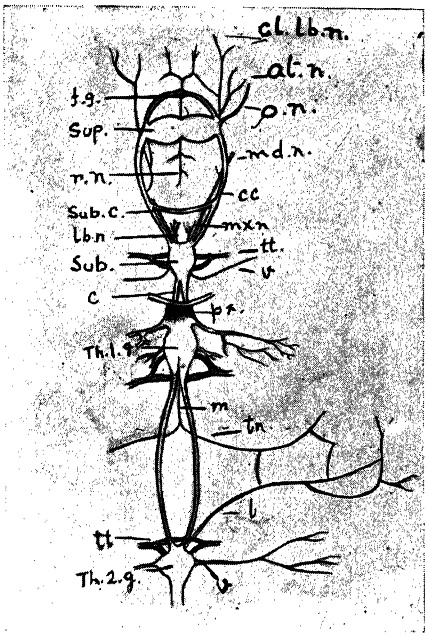

FIG. 1

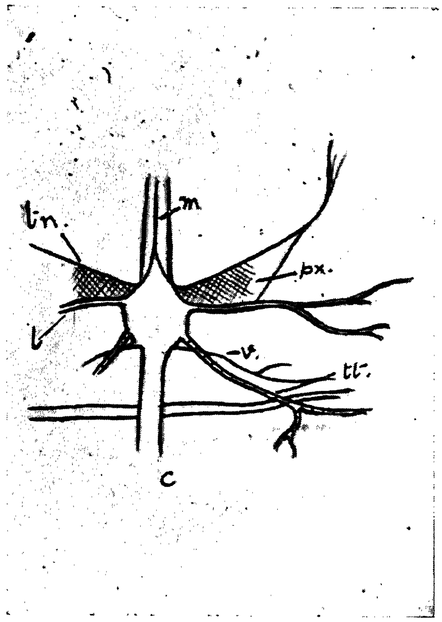

FIG. 2

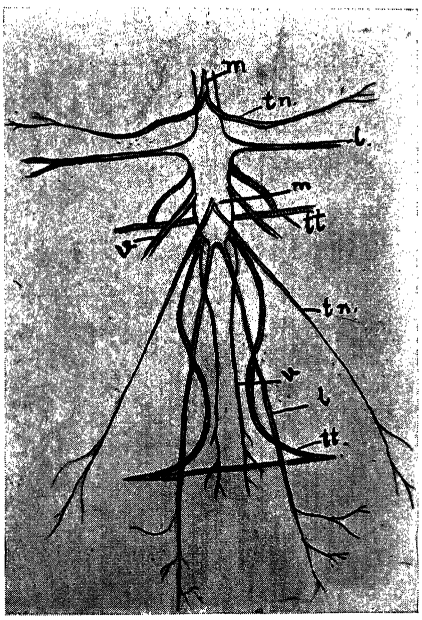

FIG. 3

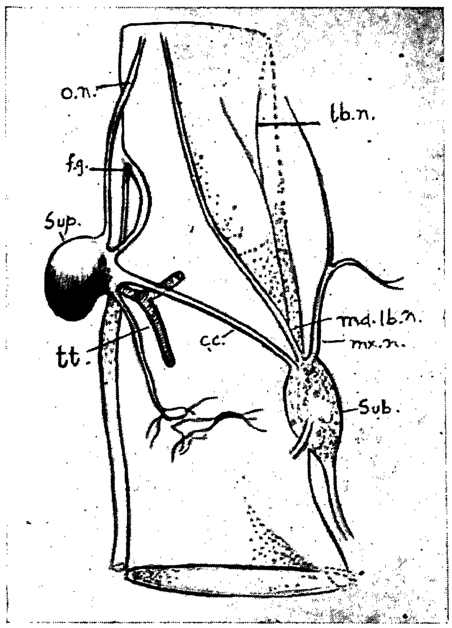

FIG. 4

THE HISTORY AND TAXONOMY OF *HISTIOSTOMA POLYPORI* (OUDEMANS) (TYROGLYPHOIDEA: ACARI)

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Introduction

Our knowledge of the Anœtidæ (Tyroglyphidæ) has been built up by the writings of a fairly large number of acarologists of different nationalities. But the works are published in some four languages and they are very scattered. The mites of this family are particularly interesting because their " hypopi " are mostly found, attached in large numbers, upon flying insects and not as one would expect upon arthropods of the soil (Vitzthum, 1932). The nymphs and adults live in concealed habitats and are therefore to a large extent unknown. Much of the fundamental systematic work has been done by Oudemans, who has studied practically every group and laid the foundations of the modern system of classification. Vitzthum (1932) commented:

" Oudemans' division is a clear one, free from any reproach. This division could be based for the most part only on the knowledge of the deutonymph (hypopi). How this division could be worked out on the knoweldge of the adults cannot be foreseen even to-day because the great majority of adults are still unknown."

The different stages of *Histiostoma polypori* (Oudemans) were reared from hypopi obtained on the European earwig *Forficula auricularia* Linn., at Edinburgh on a diet of decomposing animal and vegetable matter (Behura, 1950). In this paper, the author has endeavoured to assign *Histiostoma polypori* to its proper systematic position. Previously only a brief description of the hypopus stage by Oudemans (1914) had been made.

History and Taxonomy of Genus *Histiostoma*

According to older classification (Michael, 1901, 1903), the family "Tyroglyphidæ " was used to include the sub-family Histiostominæ. According to recent classification (Vitzthum, 1929; Zachvatkin, 1941; Solomon, 1946; Hughes, 1948) the family Tyroglyphidæ, as it was usually known,

and which included the sub-families Lentungulidæ, Histiostominæ and Tyroglyphinæ (Michael, 1901) is now replaced by the sub-cohort Tyroglyphoidea. The sub-family Histiostominæ with its single genus *Histiostoma* of Michael is now recognised as a genus of the family Anœtidae, the family Tyroglyphidæ being employed to embrace the following genera: *Tyroglyphus, Tyrophagus, Tyrolichus, Aleuroglyphus, Caloglyphus, Acotyledon, Rhizoglyphus* and *Tyreophagus* (Hughes, 1948) (Table I).

The genus *Anœtus* was first used by Oudemans (Michael, 1903) instead of *Histiostoma*. But later Oudemans (1939) himself recognised *Histiostoma* as a valid genus of the family Anœtidæ (Table I), although *Anœtus* is still retained as another separate genus (Vitzthum, 1941).

The family Anœtidæ (Oudemans, 1904) now includes the following twelve genera (Vitzthum, 1932; Oudemans, 1932; Womersley, 1941):

1. *Anœtus* Dujardin, 1842; Type: *Hypopus alicola* Dujardin, 1849.
2. *Myianœtus* Oudemans, 1929; Type: *Acarus muscarum* Linné., 1758.
3. *Prowichmannia* Redford, 1950 (= *Wichmannia* Oudemans, 1929); Type: *Histiostoma spiniferum* Michael, 1901.
4. *Histiostoma* Kramer, 1876; Type: *Histiostoma pectineum* Kramer, 1876 = *Tyroglyphus rostroserratus* Mégnin, 1873 (= *Zschachia* Oudemans, 1929; Type: *Hypopus feroniarum* Dufour, 1839 = *Tyroglyphus rostroserratus* Mégnin, 1873).
5. *Anœtoglyphus* Vitzthum, 1927; Type: *Anœtoglyphus ateuchi* Vitzthum, 1927.
6. *Glyphanœtus* Oudemans, 1929; Type: *Glyphanœtus fulmeki* Oudemans, 1929.
7. *Mauduytia* Oudemans, 1924; Type: *Anœtus tropicus* Oudemans, 1911.
8. *Zwickia* Oudemans, 1924; Type: *Anœtus guentheri* Oudemans, 1915.
9. *Cederhjelmia* Oudemans, 1931; Type: *Cederhjelmia quadriuncinata* Oudemans, 1931.
10. *Creutzeria* Oudemans, 1932; Type: *Creutzeria tobaica* Oudemans, 1932.
11. *Anœtostoma* Womersley, 1941; Type: *Anœtostoma oudemansi* Womersley, 1941.
12. *Chiropteranœtus* Womersley, 1942; Type: *Chiropteranœtus chalinolobus* Womersley, 1942.

Table I

Showing the position of the genus Histiostoma

- Order: Acari
  - Sub-Orders
    - Sarcoptiformes Reuter, 1909
      - Super cohort
        - Oribati Duges, 1834
        - Acaridideæ Latreille, 1806
          - Cohort
            - Anacotricha Oudemans, 1906
            - Diacotricha Oudemans, 1906
              - Parasitic
              - Free living usually called Sub-cohort—Tyroglyphoidea
                - Family
                  - Tyroglyphidæ Zachvatkin, 1941
                  - Glycyphaginæ Zachvatkin, 1941
                  - Saproglyphidæ Oudemans, 1924
                  - Anœtidæ Oudemans, 1904
                    - Genera
                      - 1 *Anætus* Dujardin, 1842
                      - 2 *Myianætus* Oudemans, 1929
                      - 3 *Wichmannia* Oudemans, 1929
                      - 4 *Histiostoma* Kramer, 1876
                      - 5 *Anætoglyphus* Vitzthum, 1927
                      - 6 *Glyphanætus* Oudemans, 1929
                      - 7 *Mauduytia* Oudemans, 1924
                      - 8 *Zwickia* Oudemans, 1924
                      - 9 *Cederhjelmia* Oudemans, 1931
                      - 10 *Creutzeria* Oudemans, 1932
                      - 11 *Anætostoma* Womersley, 1941
                      - 12 *Chiropteranætus* Womersley, 1942
    - Trombidiformes Reuter, 1909
    - Parasitiformes Reuter, 1909

The genus *Sellea* Oudemans, 1929 (Type: *Histiostoma pulchrum* Kramer, 1886) (Vitzthum, 1932) is no longer valid as Oudemans later (1939) placed *Histiostoma pulchrum* Kramer, 1886 as a synonym of *Histiostoma armatus* Can. and Fanz., 1876.

The genus *Histiostoma* includes 32 species and is the largest in the family Anœtidæ (Vitzthum, 1932). By 1952 ten more species of the genus including the substitution of *Histiostoma gervaisi* Oudemans, 1936 for *Hypopus ovalis* Gervais, 1844 have been described to increase the total to 42.

The genus *Histiostoma* has been redescribed by Vitzthum (1941) thus:

Histiostoma Kramer, 1876

" *Histiostoma* Kramer, 1876 (Type: *Histiostoma pectineum*, 1876) (= *Zschachia* Oudemans, 1929; Type: *Hypopus feroniarum* Dufour, 1849 = *Anœtus insularis* Oudemans, 1914) is distinguished from *Anœtus* Dujardin, 1842 (Type: *Hypopus alicola* Dujardin, 1849 = *Anœtus discrepans* Oudemans, 1903) only by its deutonymph (hypopus) in that in the deutonymph of *Histiostoma* the coxal plate of I and II each possesses an unknowable sucker while in the case of *Anœtus* a small rudimentary angular club-shaped hair is seen in its place. Comparison between the adults of the two genera is not possible as adults of *Histiostoma* are only known while those of *Anœtus* are still unknown. Under the circumstances, it can be understood that many deutonymphs (hypopi) belonging to the genus *Histiostoma* have been wrongly described under the genus *Anœtus*. The real number of species of *Anœtus* runs to-day at best to 5 as against 35 of *Histiostoma*."

Only four British species of the genus *Histiostoma* are described by Michael (1901). Of these, two, *viz.*, *H. pulchrum* Kramer and *H. spiniferum* Michael, have been renamed, *H. armatus* and *Wichmannia spiniferum* respectively (Oudemans, 1929 *a*, 1939). Hence, as far as the writer is aware, *H. polypori* is the fourth valid species of the genus *Histiostoma* to be recorded and described from the British Isles.

HISTORY OF *Histiostoma polypori* (OUD.)

The earliest mention of the mite, presumably of *H. polypori*, in literature, is that by Frisch in 1720 (Oudemans, 1929). He recorded the occurrence of " lice " on the field-cricket.

Baker (1743) mentions the occurrence of " minute insects " (hypopi of *H. polypori* ?) on the common earwig.

Later, Pou (1765) quoted Baker in his Encyclopædia. There appears to be no mention of this mite during the whole of the nineteenth century.

Lucas (1904) casually reported *F. auricularia* (or *lesni* ?) being attacked by " scarlet acarine mites ". Brindley (1912) recorded an infestation of " Gamasid mites " on laboratory reared *F. auricularia* which he obtained from the Farne Islands. Crumb *et al.* (1941) reported the infestation of *F. auricularia* by " the migratory nymphs of a species of mite of the family Tyroglyphidæ, which are merely riders and not parasitic". The size of the hypopial mites in relation to the body of *Forficula,* as shown in their photograph, appears to be much larger than that of the hypopi of *H. polypori.* The comparison with respect to size infers that the hypopial nymphs on *Forficula* discovered by the above workers are not those of *H. polypori* but probably of another species of Acari.

Oudemans (1914) was the first to describe the hypopial Tyroglyphoid mite found on *F. auricularia* under the name of *Anœtus polypori.* He also discovered the mite on the fungus *Polyporus* and on *Eugamasus cornutus* (Acarina). The same author in 1929 recorded the same on *Gryllus campestris* on the strength of information by Frisch (1720). The present writer recorded the mite on *F. auricularia* from Edinburgh (Behura, 1950). In 1954 the author also recorded that the mite was fairly well distributed in the British Isles and the hypopi occurred on the centepede *Blaniulus guthulatus* (Bou.) as well (Behura, 1954).

In 1929 Oudemans (1929 *a*) pronounced the new genus *Zschachia.* Hence the name *Anœtus polypori* changed to *Zschachia polypori.* Subsequently, the same year he made this new genus a synonym of *Anœtus.* Vitzthum (1932) opined that the generic name *Zschachia* had to disappear and that priority should be attributed to *Histiostoma.* Thus he substituted the name *Histiostoma polypori* for Oudemans' *Anœtus* (*Zschachia*) *polypori.* I share the view of Vitzthum.

TAXONOMIC DESCRIPTION OF *Histiostoma polypori*

Fam. Anœtidæ

Histiostoma polypori (Oud.).

Syn.: *Anœtus polypori* Oudemans, 1914.

Entomologische Berichten uitgegeven Door De Nederlandsche Vereeniging, **4** (76): 72.

Male—

Length of Idiosoma—210 μ to 305 μ (av. 273·4 μ).

Decidedly smaller than females. The body is dorso-ventrally flattened and opaque. With age urates aggregate in the body to give the mite a whitish

appearance. The body is clearly divided into proterosoma and hysterosoma (Fig. 1). The dorsal angles of the projections are more pointed than they are in the female (Fig. 6) although in side view, the tubercles are less marked

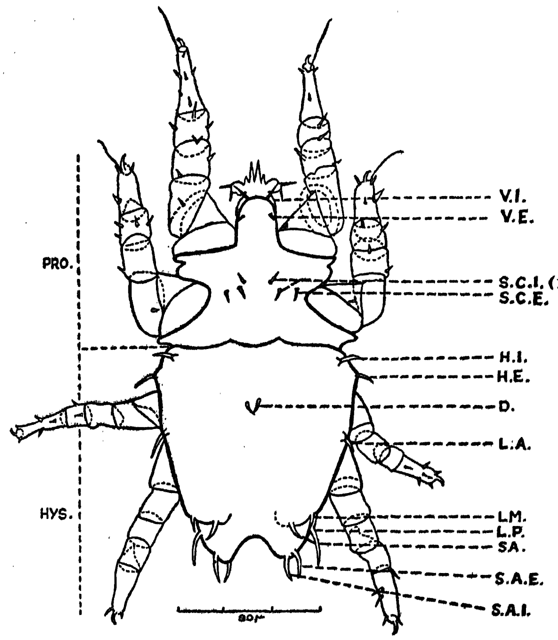

FIG. 1. *Histiostoma polypori.* Male, dorsal view. *D.*, dorsal seta; *H.E.*, external humeral seta; *H.I.*, internal humeral seta; *HYS.*, hysterosoma; *L.A.*, anterior lateral seta; *LM.*, lumbral seta; *L.P.*, posterior lateral seta; *PRO.*, proterosoma; *SA.*, sacral seta; *S.A.E.*, external posterior seta; *S.A.I.*, internal posterior seta; *S.C.E.*, external scapular seta; *S.C.I.*, (1 and 2), internal scapular setæ; *V.E.*, external vertical seta; *V.I.*, internal vertical seta.

than in the female (Fig. 2). The greater width of the body is immediately behind the transverse constriction marking the division between proterosoma and hysterosoma (Fig. 1). It tapers towards the posterior margin, which is deeply indented in the middle so as to present a bifid appearance. The hysterosoma is larger than the proterosoma. The hysterosoma bears on each lateral edge three or four large flat but raised hump—the mammilliform elevations or tubercles of Michael. Of these, one in the anteriormost region of metapodosoma and two in the posterior region of opisthosoma are very pronounced. The latter are the most prominent, particularly when they are viewed from the side (Fig. 2). They form the posterior projecting corner of the abdomen (Fig. 1). Usually each tubercle has one seta but the last but one which has two is an exception. The setæ all over the body are usually small and smooth. The vertical internal setæ (*V.I.*) do not project beyond the distal end of gnathosoma. The external vertical setæ (*V.E.*) are

shorter by half than the internal setæ and posterior in position. Across the mid-dorsal region of the propodosoma arise four internal scapular (*S.C.I.* 1 and 2) and two external scapular setæ (*S.C.E.*). On the anterior lateral

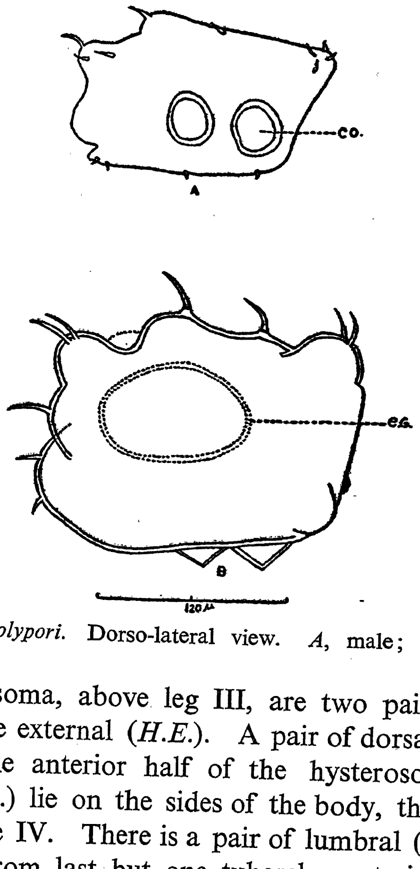

FIG. 2. *Histiostoma polypori.* Dorso-lateral view. *A*, male; *B*, female; *co.*, coxa; *e.G.*, egg.

corner of the hysterosoma, above leg III, are two pairs of humerals—the internal (*H.I.*) and the external (*H.E.*). A pair of dorsals (*D.*) are arranged on the mid-line in the anterior half of the hysterosoma. Two pairs of laterals (*L.A.* and *L.P.*) lie on the sides of the body, the more anterior ones arising above the coxæ IV. There is a pair of lumbral (*LM.*) and a pair of sacrals (*SA.*) arising from last but one tubercles anterior and dorsal to *L.P.* The posterior end of the body bears a pair of setæ, the internal posterior (*S.A.I.*) and the external posterior (*S.A.E.*).

On the ventral surface, two pairs of anal setæ (*A.*) lie on either side of the anal opening, a pair of post-anal setæ (*P.A.*) are posterior to it and two pairs of coxal setæ (*C.*) between coxæ II and coxæ IV (Fig. 3). A small pair of setæ—the intersternals (*I.S.*) lie on the sternum. There are two small setæ, on each side of the two pairs of genital suckers besides a pair of genitals (Fig. 3).

The epimera of the first pair of legs are joined to the sternum; those of the second and third pair are free, but are large and almost continuous. The fourth are well marked and are of the reversed Y type.

The genital and anal areas are well marked owing to the presence of well-defined chitinous plate lying between coxæ of legs IV. There are two pairs of small chitinous rings anterior to the penis situated between epimera

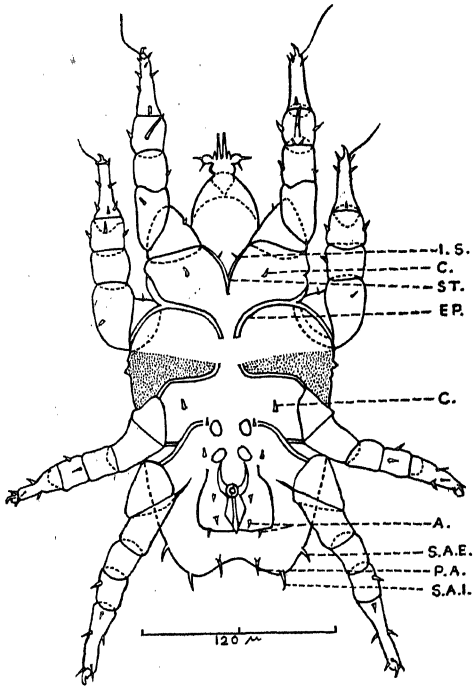

FIG. 3. *Histiostoma polypori.* Male, ventral view. *A.*, anal setæ; *C.*, coxal seta; *EP.*, episternum; *I.S.*, intersternal seta; *P.A.*, post-anal seta; *S.A.E.*, external posterior seta; *S.A.I.*, internal posterior seta; *ST.*, sternum.

of legs IV. The anterior pair of these rings are rather larger and rather farther apart than the posterior pair (Fig. 3).

The gnathosoma as in the female is long, narrow and bulbous at the proximal end. The cheliceræ are saw-shaped. The anterior part is pointed and bears teeth upon the narrow portion which is curved inwards and are about uniform size, except the two anterior which are larger and more pointed than the others and terminal (Fig. 4). Attached to the proximal portion of the chelicera is a very small saw-like appendage with two distally placed large teeth which curve inwards. About the mid-position of this appendage is a single tooth which curves inwards opposite the middle region of the exposed portion of the lingua (Fig. 4 B). The palpi have two flagella of about equal length, the anterior one being stouter and a little longer (Fig. 4 C). The flagella are slightly curved and taper to a point which is slightly hooked.

There are three small pointed setæ on the dorsal surface of the distal joint of the palpus just in front of the base of the dorsal flagellum. From the base of the dorsal free end of the palpus arises a rather long flagellum

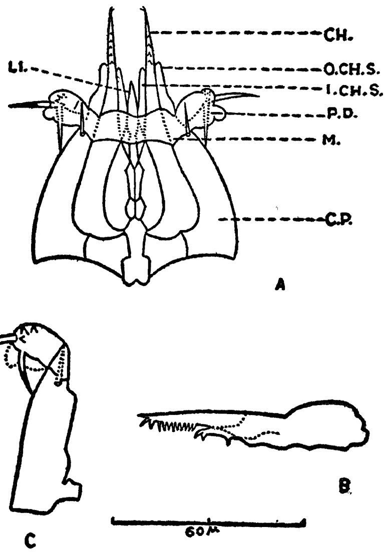

FIG. 4. *Histiostoma polypori.* *A*, hypostome; *B*, Chelicera; *C*, pedipalp; *CH.*, chelicera; *C.P.*, coxal region of pedipalp; *FL.*, flagellum; *I.CH.S.*, inner cheliceral teeth; *LI.*, lingua; *M.*, membranous expansion of the palpi; *O.CH.S.*, outer cheliceral sheath; *P.D.*, pedipalp.

which extends upwards and forwards towards the membranous expansion (*M.*) of the palpus (Fig. 4, A and C).

These membranous expansions of the palpi are bilobed and much wider than the palpi; they extend along the anterior end of the maxillary lip and join in the median line, forming a funnel down which the liquid nourishment passes (Fig. 4, A).

The legs are much stouter than those of the female and the anterior legs are thicker than the posterior ones (Figs. 1 and 3).

The leg possesses five free joints, the coxa being fused with the ventral body surface. The tarsus terminates in a single claw which is enveloped in a minute pulvillus. The claw is short, strong and sharply curved (Fig. 5).

The tarsus bears a number of spines and setæ. Tarsi I and II have the same arrangement. The setæ on tarsi II and IV are less than the above. At the base of the tarsi I and II is a leaf-like sensory end organ (Fig. 5 A). Tarsi I and IV are equal (about 50 μ including claw) and longer than tarsi II and III (about 44 μ including claw) which are also equal in length.

The males are heteromorphic. The bigger variety is very robust, the anterior part of the hysterosoma being very broad and curved behind in the form of semi-circle. The legs are light reddish brown in colour. The spines of the legs are very stout and prominent.

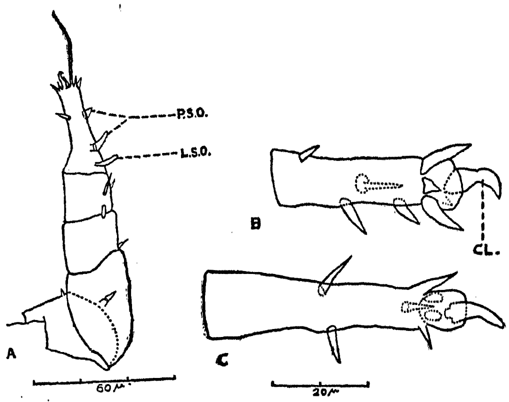

FIG. 5. *Histiostoma polypori*. Dorso-lateral view of legs of male. *A*, right leg II; *B*, tarsus of right leg III; *C*, tarsus of right leg IV; *CL.*, claw; *L.S.O.*, leaf-like sense organ; *P.S.O.*, pointed peg organ.

Female—

Length of Idiosoma—358 μ to 477 μ (av. 398 μ).

The female is larger than the male in size. The hysterosoma is at least parallel-sided for most of its length and even slightly pyriform, reaching its maximum width just before the posterior margin, which is rounder and slightly concave at the posterior end (Fig. 6). These characters are prominently marked when the adult female is about two days old. The surface of the body though dotted is shining in texture. There are three pairs of dorso-lateral tubercles each with a fairly large lateral setæ (Fig. 6). The posterior tubercle constitutes the postero-lateral angle (Fig. 6). The tubercles become more pronounced as growth proceeds.

The arrangement of setæ on the body is similar to that in the male, except that there are two pairs of scapular (*S.C.E.* and *S.C.I.*) instead of three. In addition, there lie a pair of small humeral (*H.*) setæ in a dorso-lateral position on the line dividing the proterosoma and hysterosoma (Fig. 6).

Ventrally there are two pairs of chitinous rings or discs (Fig. 7). The first pair is situated anteriorly and laterally, one on each side between the line of demarkation between the proterosoma and hysterosoma and the epimeron of the third pair of legs. The second pair of rings lie on each side of the mid-line between the legs III and IV.

The genital opening lies medially and posteriorly between the coxæ of the fourth pair of legs. The vulva is a mere slit (Fig. 7).

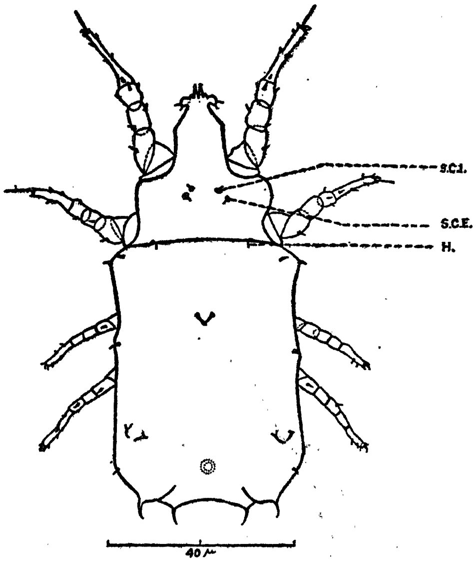

FIG. 6. *Histiostoma polypori.* Female, dorsal view. *H.*, humeral seta; *S.C.E.*, external scapular seta; *S.C.I.*, internal scapular seta.

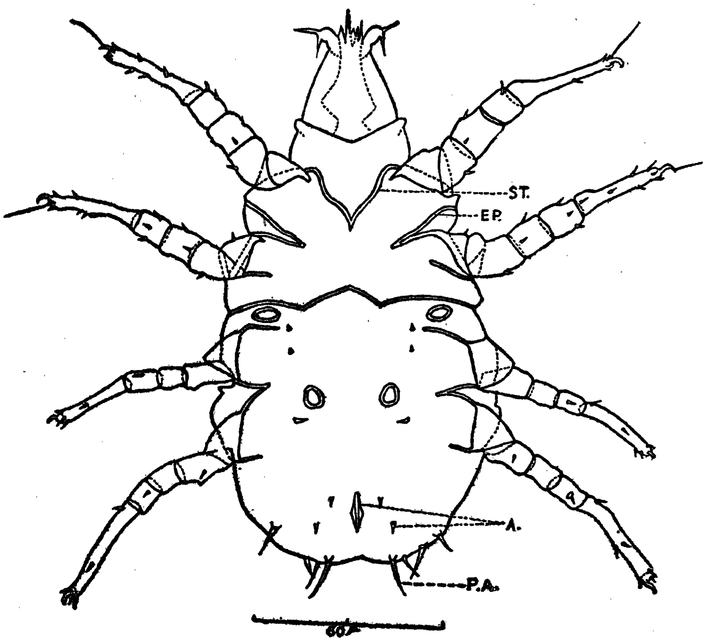

FIG. 7. *Histiostoma polypori.* Female, ventral view. *A.*, anal setæ; *EP.*, episternum; *P.A.*, post-anal seta; *ST.*, sternum.

The arrangement of setæ on the ventral side of the body and on the legs is almost similar to that of the male. The two small intercostal setæ present on each side of the sternum of the male are absent in the female. The legs are not so strongly constructed as those of the males. The epimera of the third pair of legs are similar to those of the fourth.

The tarsi are comparatively longer than that of the male. Tarsus I is equal to tarsus IV (about 70 μ including claw) and tarsus II and tarsus III (about 53 μ including claw) are equal.

At the base of the tarsus arises a small spine. On the side there are two leaf-like structures (*L.S.O.*) which probably have a sensory function (Fig. 8, A). External to the small spine there is one bigger setæ. Besides there are a number of spines situated as shown in Fig. 8, A.

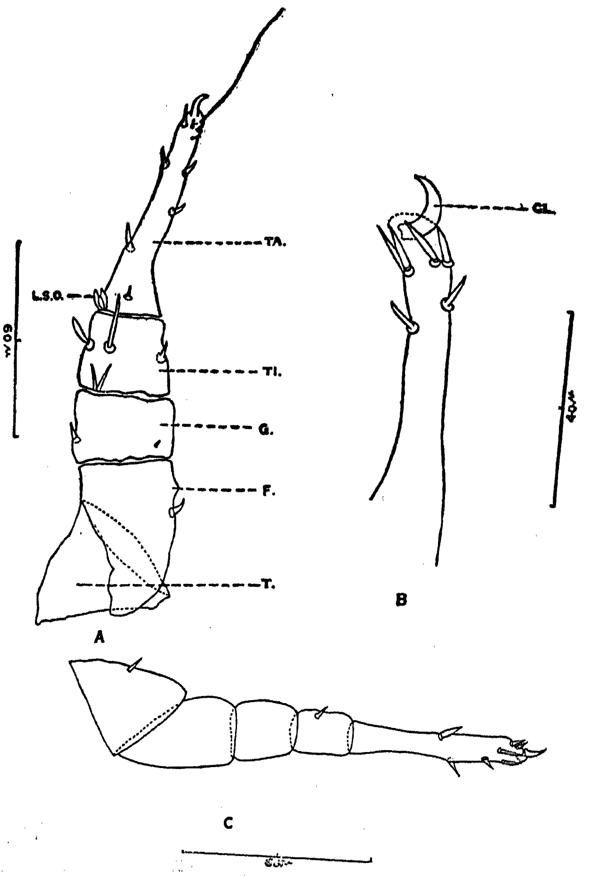

FIG. 8. *Histiostoma polypori.* Dorso-lateral view of legs of female. *A*, right leg I; *B*, tip of tarsus of right leg I magnified; *C*, right leg III; *CL.*, claw; *F.*, femur; *G.*, genu; *L.S.O.*, leaf-like sense organ; *T.*, trochanter; *TA.*, tarsus; *TI.*, tibia.

Hypopus—

Total length—158 μ to 179 μ (av. 166 μ).

There is a considerable variation in size of hypopi even when they have originated from a pure culture.

The general form is shield-shaped. The body is convex and broadly oval, with a pointed anterior and rounded posterior edge (Fig. 9). The newly formed hypopi is rosy-pink in colour but it becomes darker and browner

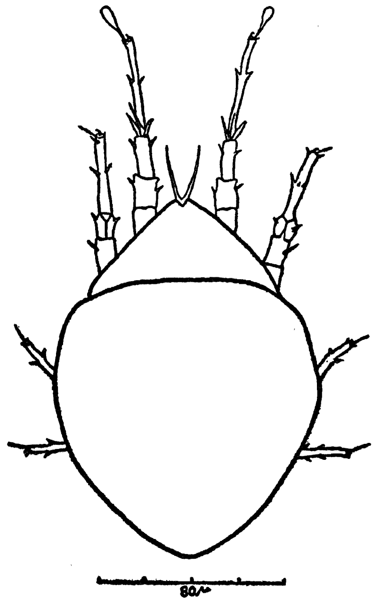

FIG. 9. *Histiostoma polypori.* Hypopus, dorsal view.

after a time. The legs are the same colour as the body. The dorsal surface has a polished appearance and is devoid of hairs. It is slightly divided between the second and third pair of legs. The anterior extremity of the propodosoma is slightly notched in the middle.

The ventral side of the body is slightly concave, nearly flat and anteriorly bears a small rostrum (Fig. 10). This terminates in a long narrow lip from which project two long bristles flanked by two such shorter setæ (Figs. 10 and 11 E).

The sucker plate lies between the fourth pair of legs and is more chitinised than the rest of the body (Fig. 10). The sucker-plate is broader than long; the anterior margin is straight with pointed corners whilst the posterior margin is curved. The plate itself contains altogether five pairs of suckers. They are arranged in three almost transverse lines. Of these the first,

second and fourth pairs are easily distinguished. The second pair are large and complex. The first appear somewhat rectangular and the fourth are oval when viewed from above. The fifth are somewhat sunken (Fig. 10).

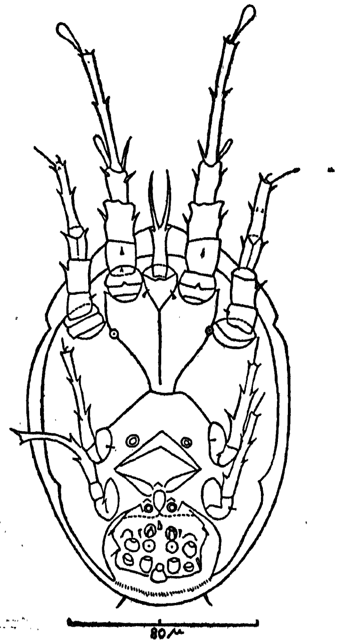

FIG. 10. *Histiostoma polypori.* Hypopus, ventral view.

There are three pairs of spines on the sucker plate, the position of which is shown in Fig. 10. The border of the sucker-plate is beset with very minute hairs.

Besides these suckers arranged on this ventral plate there is a pair on each side of the anus, a pair of antero-lateral suckers lying close to the base of coxa II (Fig. 10), and a posterior pair lie in front of a triangular chitinised area situated between the bases of the third and fourth legs (Fig. 10).

The first pair of legs are longer than half the length of the entire body (Fig. 10). Tarsus I (about 55 μ) is longer than the other four joints put together (about 46 μ), but it is very much thinner and almost even thickness throughout. All the legs are terminated by a small claw and a long hair which is not long in the tarsus I. The first pair of legs have each a longish stalked caroncle or sucker (Fig. 11, A).

At the base of tarsus I are a pair of sensory leaf-like structures. On the anterior dorsal edge of tibia I is inserted a whip-like setæ. The coxal joints of the legs are fused with the body and the anterior edges thickened

to form apodemes. Those of leg I are short and fused to a long sternal sclerite; those of leg II are curved and free, but join with those of leg III; those of leg II are directed anteriorly to join; those of leg IV joined anteriorly to form a triangle (Fig. 10).

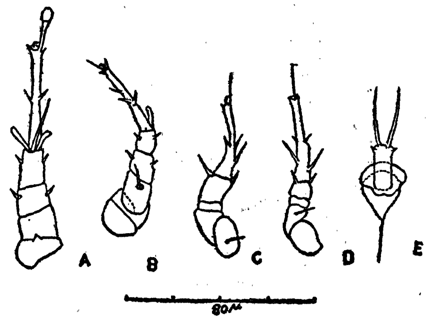

FIG. 11. *Histiostoma polypori.* Hypopus, dorso-lateral view of the legs, mouth and sternum. *A*, leg I; *B*, leg II; *C*, leg III; *D*, leg IV; *E*, mouth and sternum.

The first and second pairs of legs are usually stretched out and lie almost close together when the hypopus is adhering to insects, etc., and the two hind pairs doubled forward under the hysterosoma.

My figure of the ventral view of the hypopus (Fig. 10) corresponds with that figured by Berlese (1925) for *Histiostoma* sp.

Deutonymph—

Length of Idiosoma—205 μ to 242 μ (av. 222 μ).

There are five pairs of very pronounced tubercles. The anteriormost pair lie in the propodosoma and the rest in the hysterosoma (Fig. 12). One unpaired tubercle lies in the anterior half of the hysterosoma. A fairly large seta arises from each tubercle. The legs are stouter and the body more robust than is the case in the protonymph. Two pairs of suckers, the posterior pair being more oval, lie above the anal opening between the coxæ of the third and fourth pair of legs (Fig. 13).

The shape of the body of the deutonymph indicates quite clearly the male or female nature of the adult stage.

The arrangement of the setæ on the legs is almost identical with that of the adult.

Protonymph—

Length of Idiosoma—147 μ to 200 μ (av. 162·4 μ).

The general shape of the body simulates that of the female. The tubercles are not well pronounced and the body surface is smooth. The median

tubercle present in the hysterosoma of the deutonymph is missing in the protonymph. In the region of the anteriormost pair of tubercle lying in

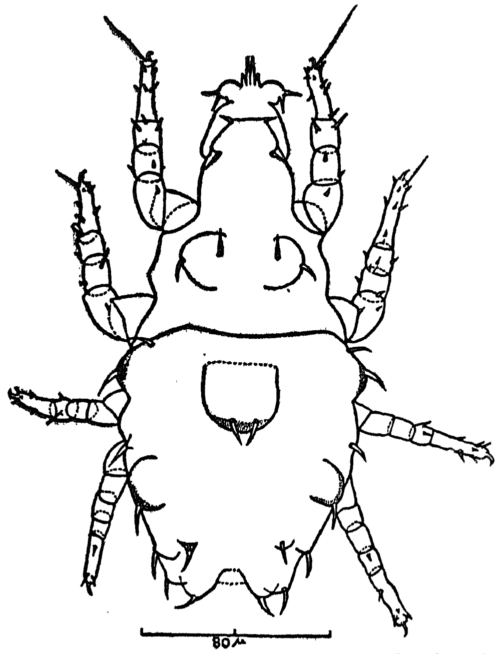

FIG. 12. *Histiostoma polypori.* Deutonymph, dorsal view.

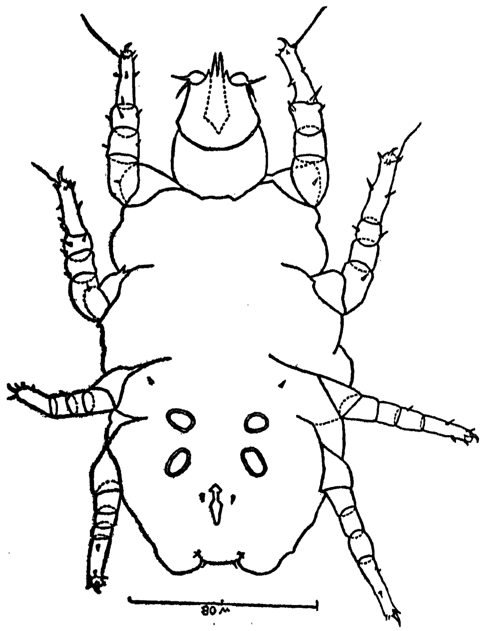

FIG. 13. *Histiostoma polypori.* Deutonymph, ventral view.

the propodosoma there are three pairs of setæ whereas in the corresponding region of the deutonymph there are only two pairs (Fig. 14).

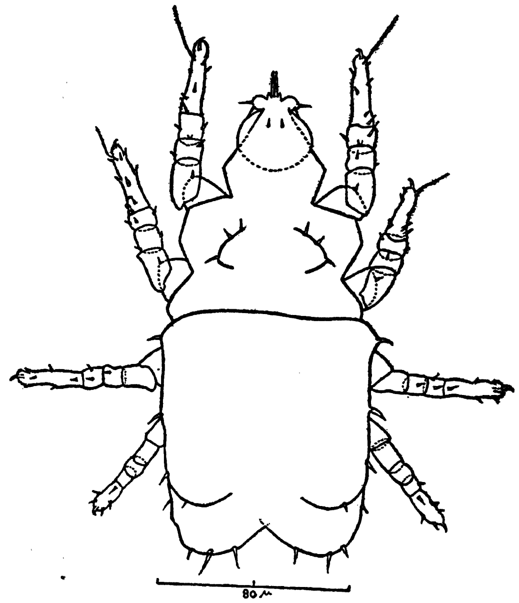

FIG. 14. *Histiostoma polypori.* Protonymph, dorsal view.

There are only a pair of suckers between the coxæ of the fourth pair of legs anterior to the anal aperture (Fig. 15).

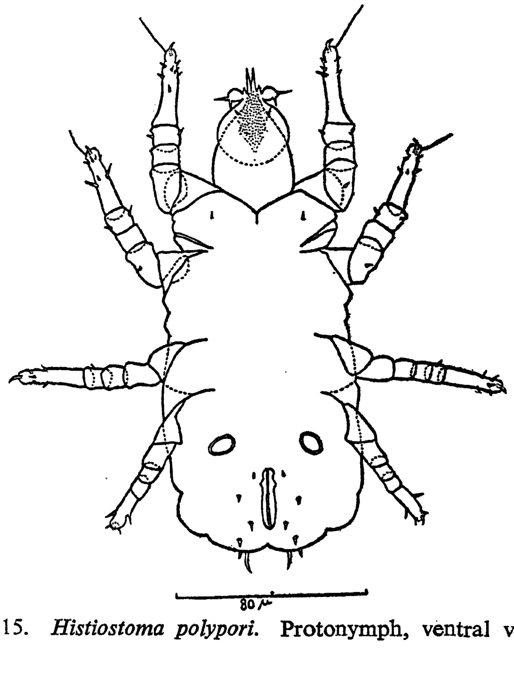

FIG. 15. *Histiostoma polypori.* Protonymph, ventral view.

Larva—

Length of Idiosoma—126 μ to 147 μ (av. 134·3 μ).

The larva is more or less like the adult male except that the fourth pair of legs are wanting. The surface of body is very uneven due to the presence of five pairs of dorsal tubercles besides two median ones, one anteriormost and the other in the posteriormost region of the hysterosoma (Fig. 16, A). The rough surface of body is well marked in side view. The last pair of tubercles form the posterior border (Fig. 16, A and B).

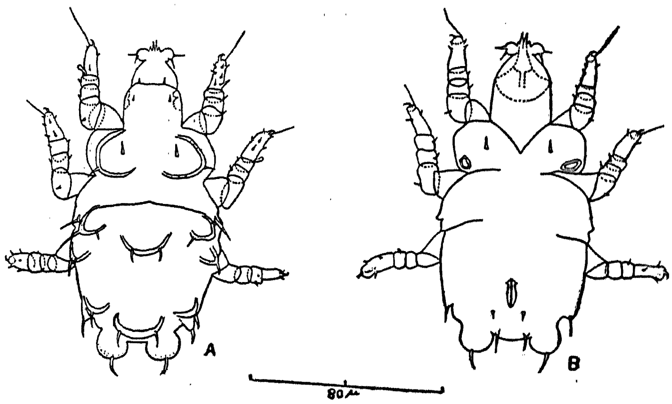

FIG. 16. *Histiostoma polypori*. Larva. *A*, dorsal view; *B*, ventral view.

Just anterior to the coxæ of the second pair of legs are two oval sucker-like structures (Fig. 16, B) the " bruststiele " of Michael. Michael (1901) noted that these organs are present throughout the genus *Tyroglyphus* and some others, but does not mention them in *Histiosoma*. Jary and Stapley (1936) mention them in *H. rostroserratum* Meg., and point out Michael's omission.

Egg—

The eggs are very hygroscopic, transparent and measure about 84 μ $\times$ 59 μ.

SUMMARY

A short history of *Histiostoma polypori* (Oud.) is given. The species is assigned to the family Anœtidæ. Full taxonomic descriptions are given for the different stages from egg to adult including the hypopus stage.

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